

CLAIMS

1. A continuous vacuum carburizing process comprising: under a reduced pressure of 5 kPa or less, forming at least one carburizing atmosphere in which pressure and gas composition are constant with one of chain saturated hydrocarbon, chain unsaturated hydrocarbon gas and cyclic hydrocarbon used as a carburizing medium; activating carbon in the carburizing atmosphere; and passing one material of a metal wire, a metal strip and a metal pipe, which has a carbon content equal to or less than a desired carbon content, continuously through the carburizing atmosphere and thereby carburizing the material.
2. The continuous vacuum carburizing process according to claim 1, further comprising heating a fixed area, through which the material passes following the carburizing atmosphere and in which the carburizing medium does not exist, and causing the carbon carburized in the material to be diffused into inner sections of the material.
3. The continuous vacuum carburizing process according to claim 1, wherein said activating carbon comprises heating the carburizing atmosphere to 850°C to 1050°C.
4. The continuous vacuum carburizing process according to claim 1, wherein said activating carbon comprises bringing the carbon into a plasma state and heating the carburizing atmosphere to 400°C to 1050°C.

5. The continuous vacuum carburizing process according to claim 1, further comprising lowering pressure in a surrounding area of the carburizing atmosphere than the pressure of the carburizing atmosphere.
6. The continuous vacuum carburizing process according to claim 2, further comprising supplying and discharging carrier gas to/from the fixed area and forming carrier gas atmosphere in the fixed area.
7. The continuous vacuum carburizing process according to claim 2, said passing the material through the carburizing atmosphere and then through the fixed area is repeated multiple times.
8. The continuous vacuum carburizing process according to claim 1, wherein carburizing is performed until the material reaches or exceeds the desired carbon content.
9. The continuous vacuum carburizing process according to claim 1, wherein the material has a diameter of 0.02 mm to 3 mm in case of the metal wire, a thickness or width of 0.02 mm to 3 mm in case of the metal strip and a wall thickness of 0.02 mm to 3 mm in case of the metal pipe, and the material is carburized to a center of its cross section.
10. The continuous vacuum carburizing process according to claim 1, wherein the material is carburized only in a surface layer thereof.
11. The continuous vacuum carburizing process

according to claim 1, wherein the material comprises one of carbon steel for machine construction, alloy steel for machine construction, tool steel, spring steel and stainless steel.

12. The continuous vacuum carburizing process according to claim 1, wherein the material comprises one of a nickel alloy and a cobalt alloy containing one or more of carbide-forming elements of boron, titanium, vanadium, chromium, zirconium, niobium, molybdenum, hafnium, tantalum and tungsten.

13. The continuous vacuum carburizing process according to claim 1, wherein the material comprises one of a metal and an alloy which has as a main component one of carbide-forming elements of boron, titanium, vanadium, chromium, zirconium, niobium, molybdenum, hafnium, tantalum and tungsten.

14. A continuous vacuum carburizing apparatus comprising:

a furnace core portion formed to enclose a fixed space through which one material of a metal wire, a metal strip and a metal pipe is passed continuously;

means for supplying as a carburizing medium one of chain saturated hydrocarbon, chain unsaturated hydrocarbon gas and cyclic hydrocarbon to the furnace core portion under a reduced pressure of 5 kPa or less and discharging the carburizing medium to form at least one carburizing atmosphere in which pressure and gas composition are constant; and

means for activating carbon of the carburizing medium within the furnace core portion.

15. The continuous vacuum carburizing apparatus according to claim 14, wherein said means for activating carbon comprises an electric heater for heating the furnace core portion to 850°C to 1050°C.

16. The continuous vacuum carburizing apparatus according to claim 14, wherein said means for activating carbon comprises a discharger for causing glow discharge in the furnace core portion and an electric heater for heating the furnace core portion to 400°C to 1050°C.

17. The continuous vacuum carburizing apparatus according to claim 14, further comprising a feeding/taking-up mechanism for passing the material through the furnace core portion, and a vacuum container for receiving the furnace core portion, the supply/discharge means and the heating means, said vacuum container being kept in its inside at a lower pressure than pressure in the furnace core portion.

18. The continuous vacuum carburizing apparatus according to claim 14, further comprising means for supplying and discharging a carrier gas to/from the furnace core portion to form, on a downstream side of the carburizing atmosphere with respect to a travel direction of the material, at least carrier gas atmosphere without the carburizing medium.

19. The continuous vacuum carburizing apparatus

according to claim 14, wherein said furnace core portion and said supply/discharge means are adapted to form a plurality of carburizing atmospheres in the furnace core portion.